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US 6170261 B

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(54) Abstract Title: **Cavitation prevention by fluid supply to motor outlet**

(57) A cavitation prevention system of a hydraulically driven vehicle provided with first drive pump 12, second drive and implement valve 28 supply pump 12S, combining valve 26 for combining G pressure fluids from these pumps, a movement reversing valve 21, a vehicle speed detecting pump 17 and motor 18 set and a controller 30. When the operator switches 34 the transmission between forward and rearward drive, the controller reverses switching valve 22 and thus the reversing valve to reverse fluid supply to the motor. If the vehicle is moving its inertia causes the motor 13 to continue rotating in its original direction tending to reduce pressure in forward circuit 41F, causing cavitation. If the vehicle speed is greater or equal to a set value the controller closes B combining valve 26 sending second pump fluid via unload valve 55 to pressurise the return 43 and reduce cavitation.

FIG. 1

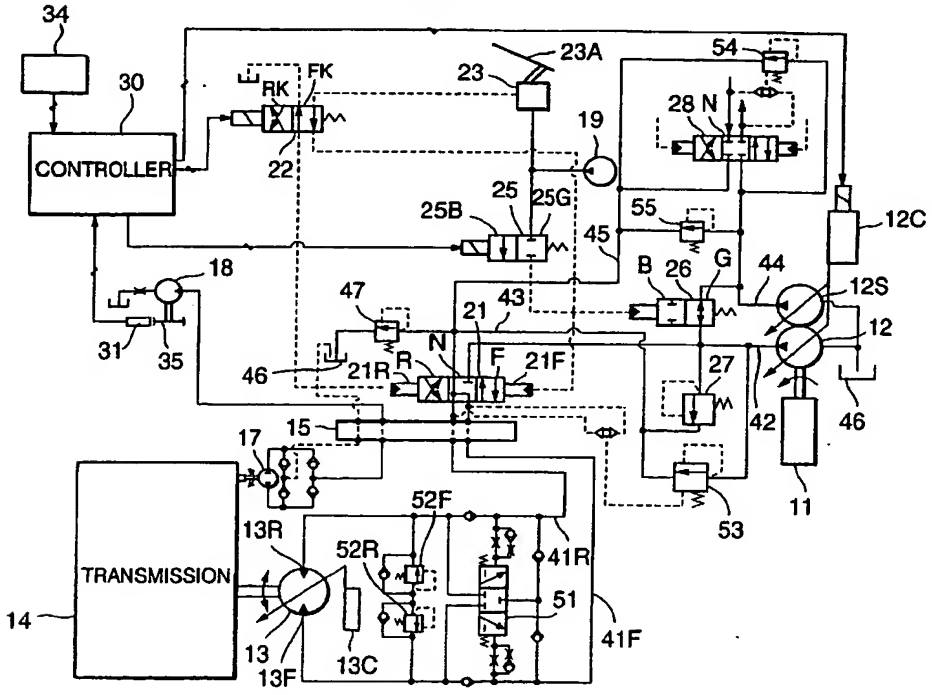

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FIG. 1

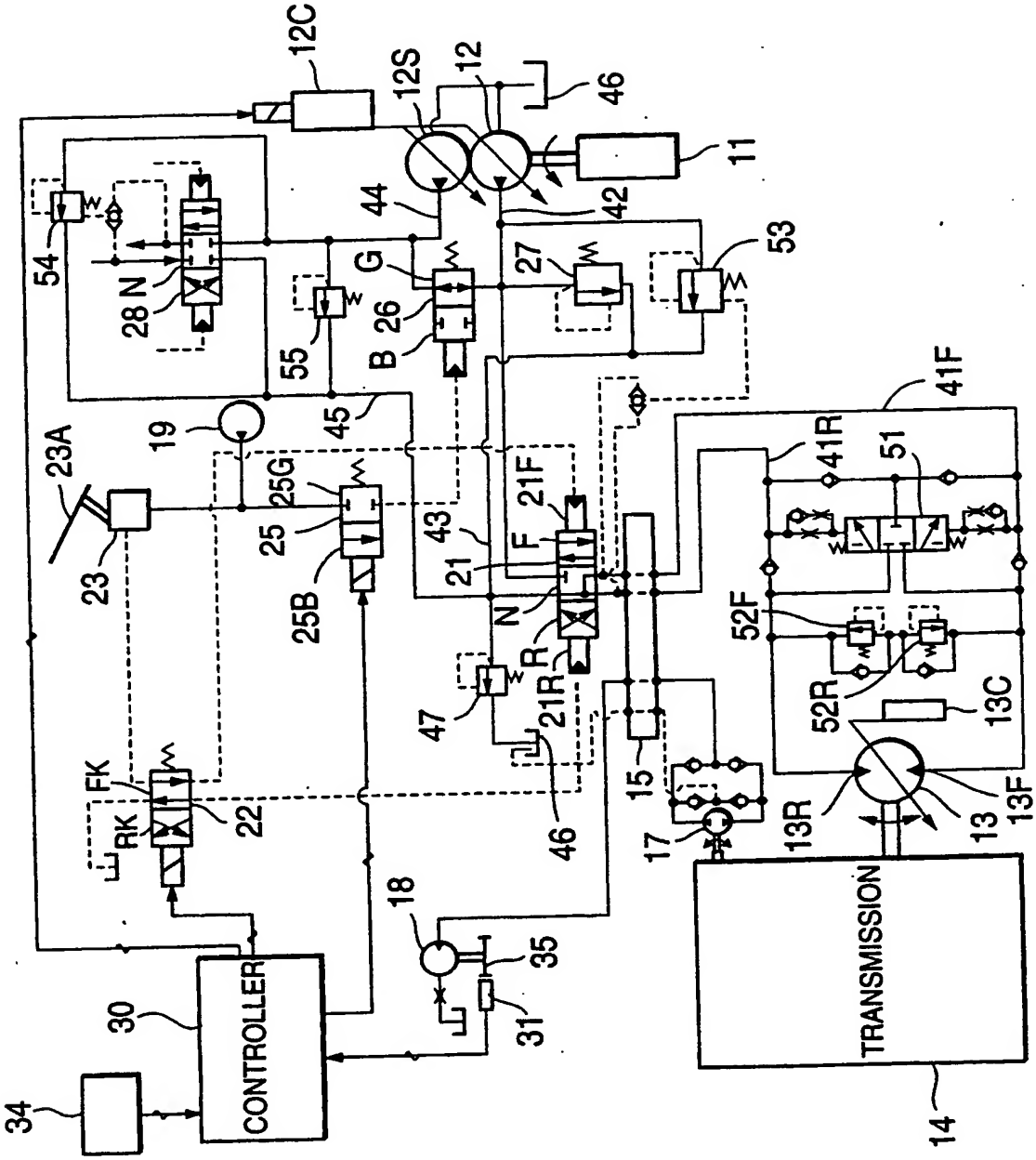
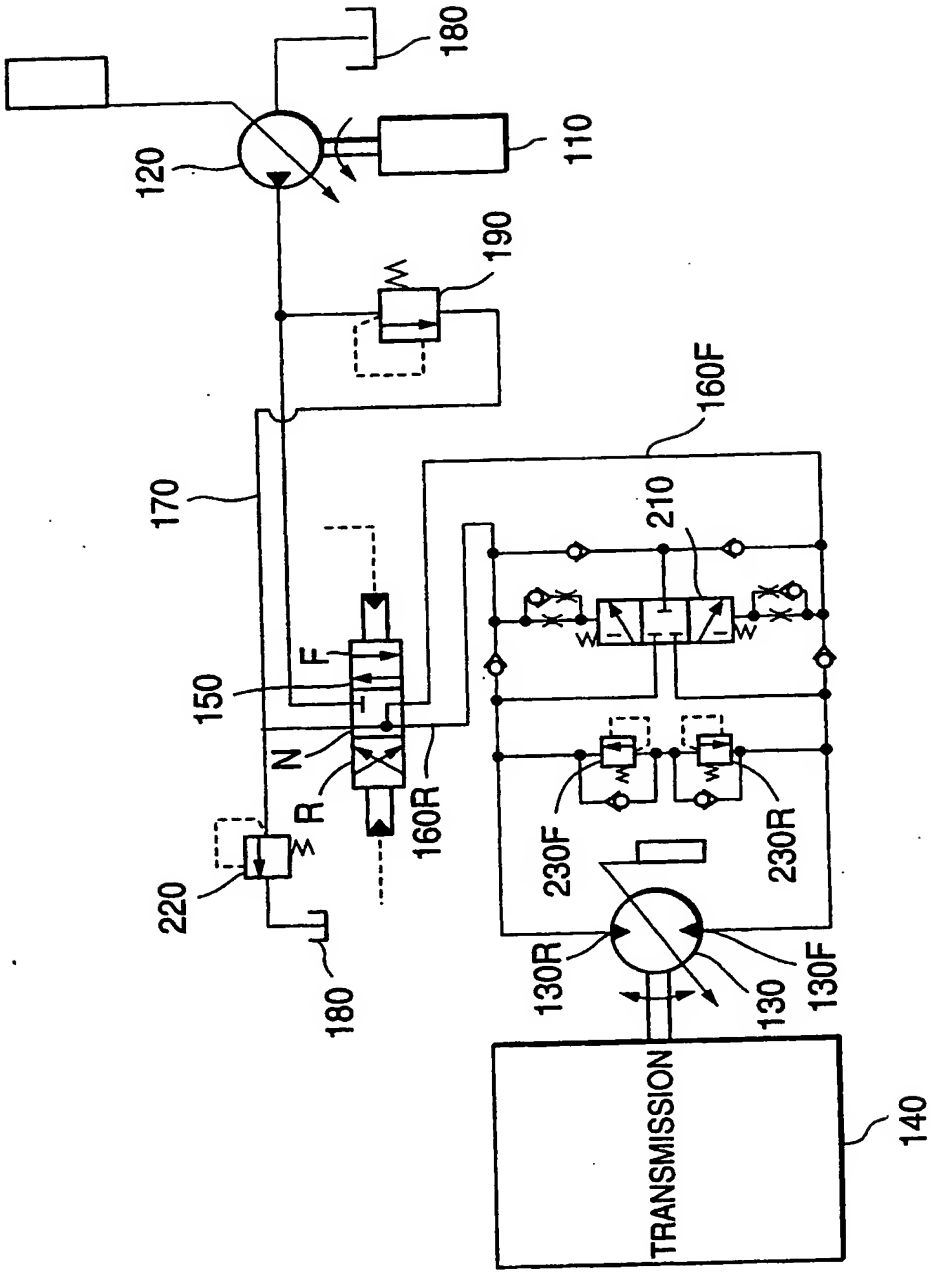

12C
12S
12
46
11
42
44
53
27
G
26
B
54
28
N
55
45
19
23A
23
25G
25
25B
43
21F
F
21
N
R
21R
47
46
FK
RK
22
18
35
31
30
CONTROLLER
34
15
17
41F
41R
51
52F
52R
13C
13R
13
13F
TRANSMISSION
14

FIG. 2 PRIOR ART



CAVITATION PREVENTION SYSTEM OF HYDRAULIC TRAVELING VEHICLE

FIELD OF THE INVENTION

The present invention relates to a cavitation prevention system of a working vehicle, in particular, of a hydraulic traveling vehicle.

BACKGROUND OF THE INVENTION

Conventionally, a hydraulic traveling vehicle is traveled by driving a variable capacity type traveling hydraulic motor 130 on the basis of a pressure fluid of a variable capacity type traveling hydraulic pump 120 driven by an engine 110, as in a hydraulic traveling system shown in Fig 2. Forward and rearward movements are switched by a traveling control valve 150, and in the case of the forward movement, the traveling control valve 150 is switched from an illustrated neutral position N to a forward movement position F. The traveling hydraulic pump 120 feeds a pressure fluid sucked from an oil tank 180 to a forward movement side circuit 160F of the traveling hydraulic motor 130. The traveling hydraulic motor 130 rotates in a forward movement direction due to the pressure fluid so as to drive a transmission 140 and make the hydraulic traveling vehicle travel. The pressure fluid output from the traveling hydraulic motor 130 passes through a counter balance valve 210, a rearward movement side circuit 160R, the traveling control valve 150 and a return circuit 170 and returns to the

oil tank 180 via a back pressure compensation valve 120.

However, when suddenly switching the traveling control valve 150 from the forward position F to a rearward position R in order to move the hydraulic traveling vehicle rearward, the forward movement side circuit 160F is connected to the return circuit 170 and the pressure fluid is not fed to a forward movement side port 130F of the traveling hydraulic motor 130, so that the traveling hydraulic motor 130 is not rotated by the pressure fluid.

On the other hand, since the hydraulic traveling vehicle keeps traveling in a forward moving direction due to an inertia, the traveling hydraulic motor 130 can not rotate in a rearward moving direction, and is reversely driven by a transmission 14 so as to rotate in the forward moving direction. A rearward movement port 130R of the traveling hydraulic motor 130 is closed by the counter balance valve 210 so as to become at a high pressure, however, a rearward movement side relief valve 230R is opened, and then the pressure fluid is fed to the forward movement side port 130F.

However, since all amount of the pressure fluid in the rearward movement side port 130R is not fed to the forward movement side port 130F due to an internal leakage of the traveling hydraulic motor 130, the traveling hydraulic motor 130 sucks the oil from the return circuit 170 via the traveling control valve 150. However, since the pressure fluid is not supplied to the return circuit 170 from any places until a relief valve 190 is open, the pressure fluid

in the forward movement side circuit 160F and the return circuit 170 is immediately short even if a back pressure compensation valve 220 is provided. Since the traveling hydraulic motor 130 keeps rotating in the forward moving direction in spite of no pressure fluid to be sucked, a cavitation is generated.

SUMMARY OF THE INVENTION

The present invention is made by taking the problems mentioned above into consideration, and an object of the present invention is to provide a cavitation prevention system of a hydraulic traveling vehicle which can securely prevent a cavitation from being generated.

In order to achieve the object mentioned above, in accordance with the present invention, there is provided a cavitation prevention system of a hydraulic traveling vehicle which comprises a first traveling hydraulic pump, a second traveling hydraulic pump, a combining means for combining a pressure fluid in the first traveling hydraulic pump and a pressure fluid in the second traveling hydraulic pump, a forward and rearward movement switching means of the hydraulic traveling vehicle, a vehicle speed detecting means of the hydraulic traveling vehicle, and a controller which switches the combining means in the case that a vehicle speed detected by the vehicle speed detecting means is equal to or more than a set value and the forward and rearward movement is switched by the forward and rearward movement switching

means, thereby not combining the pressure fluid in the first traveling hydraulic pump and the pressure fluid in the second traveling hydraulic pump and flowing the pressure fluid in the second traveling hydraulic pump to a return circuit.

Further, a discharge circuit of the second traveling hydraulic pump is provided in sequence with an unload valve and the return circuit which are branched from a portion between the second traveling hydraulic pump and a working implement valve.

In accordance with the present invention, since the pressure fluid discharged from the second traveling hydraulic pump flows through the return circuit even if the hydraulic traveling vehicle is suddenly switched to the rearward movement from the forward movement, the traveling hydraulic motor reversely driven by the inertia of the hydraulic traveling vehicle sucks the pressure fluid in the return circuit, keeps rotating in the forward moving direction and discharges the pressure fluid to the rearward movement side circuit. Accordingly, the traveling hydraulic motor can rotate without generating a cavitation, and it is possible to securely prevent the cavitation from being generated.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of a cavitation prevention system of a hydraulic traveling vehicle in accordance with the present invention; and

Fig. 2 is a schematic view of a hydraulic traveling

system of a hydraulic traveling vehicle in accordance with the prior art.

BEST MODE FOR CARRYING OUT THE INVENTION

A description will be given of a cavitation prevention system of a hydraulic traveling vehicle in accordance with the present invention with reference to the accompanying drawing. Fig. 1 is a schematic view of the cavitation prevention system.

As shown in Fig. 1, a traveling pump 12 corresponding to a first traveling hydraulic pump, and a working implement pump 12S corresponding to a second traveling hydraulic pump are connected to an engine 11. The traveling pump 12 and the working implement pump 12S are driven by the engine 11 so as to suck an oil from an oil tank 46 and discharge a pressure fluid. The pressure fluid discharged from the traveling pump 12 and the working implement pump 12S is fed to a forward movement side circuit 41F of a traveling motor 13 via a traveling control valve 21 and a hydraulic swivel joint 15. The pressure fluid rotates the traveling motor 13 in a forward moving direction, drives a transmission 14 and travels the hydraulic traveling vehicle. The pressure fluid discharged from the traveling motor 13 passes through a counter balance valve 51, a rearward movement side circuit 41R, a traveling control valve 21 and a return circuit 43, and returns to the oil tank 46 via a back pressure compensation valve 47. Further, motor relief valves 52F and

52R which connect the forward movement side circuit 41F to the rearward movement side circuit 41R are provided between the traveling motor 13 and the counter balance valve 51.

The traveling motor 13 is connected to an input shaft of the transmission 14, and drives the transmission 14. The pressure fluid from the working implement pump 12S is combined with the pressure fluid in the discharge circuit 42 of the traveling pump 12 or fed to a working implement operation valve 28 by switching a combination valve 26 corresponding to a combining means.

A travel speed detecting pump 17 is provided in the transmission 14, and is structured such as to rotate in proportion to a rotation of an output shaft of the transmission 14. The pressure fluid discharged from the travel speed detecting pump 17 is fed to a travel speed detecting motor 18 via the hydraulic swivel joint 15.

The traveling pump 12 and the working implement pump 12S are variable capacity hydraulic pumps, and each has a pump capacity control means 12C. Further, the traveling motor 13 is a variable capacity hydraulic motor, and has a motor capacity control means 13C.

The traveling pump 12 is provided with an unload valve 53 branched from the discharge circuit 42 thereof, and the working implement pump 12S is provided with an unload valve 54 branched from the discharge circuit 44 thereof.

Further, the discharge circuit of the working implement pump 12S is provided in sequence with an unload valve 55 and

the return circuit 45 branched from the portion between the working implement pump 12S and the working implement operation valve 28.

In this case, a working vehicle (not shown) is provided with a lower traveling body (not shown) and an upper revolving body (not shown). A working implement valve (not shown) is provided in the upper revolving body, and the hydraulic swivel joint 15 is provided in a connection portion between the lower traveling body and the upper revolving body. The engine 11 is provided in the upper revolving body (not shown), the transmission 14 is provided in the lower traveling body (not shown), and a controller 30 is provided in the upper revolving body (not shown).

The traveling control valve 21 is switched to a forward movement position F or a rearward movement position R from an illustrated neutral position N, and controls the pressure fluid discharged from the traveling pump 12 so as to feed to the traveling motor 13. The traveling control valve 21 is switched to the forward movement position F or the rearward movement position R from the neutral position N by receiving a pilot pressure from the forward and rearward movement switching valve 22 in a forward movement side pressure receiving portion 21F or a rearward movement side pressure receiving portion 21R.

A vehicle speed detection gear 35 for generating a vehicle speed signal is provided in the output shaft of the vehicle speed detecting motor 18, and is rotated by the

vehicle speed detecting motor 18. For example, a predetermined number of teeth, slits or concavity and convexity are formed on an outer periphery of the vehicle speed detection gear 35. A vehicle speed detection sensor 31 is provided close to the outer periphery of the vehicle speed detection gear 35, and generates a pulse which is generated, for example, at a time when a predetermined number of teeth pass through a signal detection portion of the vehicle speed detection sensor 31, as an electric signal.

The vehicle speed detection sensor 31 is connected to the controller 30. The vehicle speed detection sensor 31 corresponding to a vehicle speed detecting means transmits a vehicle speed signal as an electric signal to the controller 30. The controller 30 arithmetically processes the vehicle speed signal so as to calculate the vehicle speed.

A main relief valve 27 and a return circuit 43 are provided in sequence in the discharge passage 42 of the traveling pump 12. In the case that the pressure of the pressure fluid discharged from the traveling pump 12 and the working implement pump 12S is equal to or more than a predetermined value, the pressure fluid is relieved to the return circuit 43.

The forward and rearward movement switching valve 22 is switched to an illustrated forward moving position FK on the basis of the forward moving signal from the controller 30, and is switched to a rearward moving position RK on the basis of the rearward moving signal.

A travel pilot pressure valve 23 is operated by pedaling down an accelerator pedal 23A, and a pilot pressure from the pilot pump 19 is generated as a travel pilot pressure. The travel pilot pressure corresponding to a pedaling amount detecting means of the accelerator pedal 23A changes in correspondence to a pedaling amount of the accelerator pedal 23A; and is increased in accordance with a predetermined rate as the pedaling amount of the accelerator pedal 23A is increased.

A forward and backward movement switch 34 is connected to the controller 30, and transmits a forward movement command signal or a rearward movement command signal to the controller 30.

A combination switching valve 25 is connected to the controller 30, and is switched to an illustrated combination command position 25G or a non-combination command position 25B by an application of the signal from the controller 30.

When the forward and rearward movement switch 34 is switched to the rearward movement side from the forward movement side or to the forward movement side from the rearward movement side, the controller 30 switches the combination switching valve 25 to the non-combination command position 25B so as to switch a combination valve 26 to a non-combination position B from an illustrated combination position G in the case a vehicle speed computed by arithmetically processing a vehicle speed signal from the vehicle speed detection sensor 31 is equal to or more than a

predetermined value, for example, 0.2 km/h.

Next, a description will be given of an operation of the cavitation prevention system in accordance with the present invention.

When an operator switches the forward and rearward movement switch 34 to the forward movement side, the forward and rearward movement switching valve 22 is set to the forward moving position FK, and when pedaling down the accelerator pedal 23A, the travel pilot pressure is applied to the forward movement side pressure receiving portion 21F of the travel control valve 21, and is switched from the neutral position N to the forward moving position F.

The controller 30 switches the combination switching valve 25 to the combination command position 25G on the basis of the forward movement command signal of the forward and rearward movement switch 34, thereby switching the combination valve 26 to the combination position G.

The pressure fluid discharged from the traveling pump 12 and the pressure fluid discharged from the working implement pump 12S are combined in the discharge circuit 42 of the traveling pump 12 via the combination valve 26, and enter into the traveling control valve 21. The travel control valve 21 transmits the pressure fluid to a forward movement side port 13F of the traveling motor 13 via the hydraulic swivel joint 15. The traveling motor 13 rotates in the forward moving direction so as to drive the transmission 14, thereby moving the hydraulic traveling vehicle forward.

Thereafter, when suddenly switching the forward and rearward movement switch 34 to the rearward movement side from the forward movement side in order to move the hydraulic traveling vehicle rearward, the controller 30 switches the combination switching valve 25 to the non-combination command position 25B so as to switch the combination valve 26 to the non-combination position B from the illustrated combination position G, in the case that the vehicle speed computed by arithmetically processing the vehicle speed signal from the vehicle speed detection sensor 31 is equal to or more than the set value, for example, 0.2 km/h.

Further, when switching the forward and rearward movement switch 34 to the rearward movement side to the forward movement side, the forward and rearward movement switching valve 22 becomes at a rearward movement position RK, and the traveling control valve 21 is switched to a rearward movement position R. Accordingly, since the forward movement side circuit 41F is connected to the return circuit 43, the pressure is not fed to the forward movement port 13F of the traveling motor 13, and the traveling motor 13 is not rotated by the pressure fluid. However, since the hydraulic traveling vehicle travels in the forward moving direction in accordance with the inertia, the traveling motor 13 can not rotate in the rearward moving direction, and is rotated in the forward moving direction due to the reverse driving by the transmission 14.

Then, the traveling motor 13 is going to suck the

pressure fluid in the forward movement side circuit 41F and the return circuit 43, however, the working implement operation valve 28 is not operated due to the traveling state, and is at the neutral position N. Accordingly, the pressure fluid discharged from the working implement pump 12S passes through the return circuit 45 from the unload valve 55, and flows to the forward movement side circuit 41F via the return circuit 43 and the traveling control valve 21 set in the rearward movement position R.

As a result, since the forward movement side circuit 41F and the return circuit 43 are filled with the pressure fluid, the traveling motor 13 sucks these pressure fluids so as to keep rotating in the forward moving direction, and discharges the oil to the rearward movement side circuit 41R. Therefore, the traveling motor 13 rotates without generating any cavitation, and it is possible to securely prevent the cavitation from being generated.

The hydraulic traveling vehicle may be a vehicle having no upper revolving body, and the present invention can be applied, for example, to a wheel loader, a fork lift or the other working vehicles. In the case of applying the cavitation prevention system in accordance with the present invention to the vehicle provided with no upper revolving body, the hydraulic swivel joint 15 may be omitted.

WHAT IS CLAIMED IS:

1. A cavitation prevention system of a hydraulic traveling vehicle, said system comprising:

a first traveling hydraulic pump (12);

a second traveling hydraulic pump (12S);

a combining means (26) for combining a pressure fluid in the first traveling hydraulic pump and a pressure fluid in the second traveling hydraulic pump;

a forward and rearward movement switching means of said hydraulic traveling vehicle;

a vehicle speed detecting means of said hydraulic traveling vehicle; and

a controller (30) which switches said combining means in the case that a vehicle speed detected by the vehicle speed detecting means is equal to or more than a set value and the forward and rearward movement is switched by the forward and rearward movement switching means, thereby not combining the pressure fluid in the first traveling hydraulic pump and the pressure fluid in the second traveling hydraulic pump and flowing the pressure fluid in the second traveling hydraulic pump to a return circuit.

2. A cavitation prevention system of a hydraulic traveling vehicle as claimed in claim 1, wherein a discharge circuit of said second traveling hydraulic pump (12S) is provided in sequence with an unload valve (55) and the return circuit which are branched from a portion between the second

traveling hydraulic pump and a working implement valve (28).

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Application No:	GB 0227637.6	**Examiner:**	J. C. Barnes-Paddock
Claims searched:	1,2	**Date of search:**	9 June 2003

15

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
A		US6170261 B	(KOMATSU) See Figure 1. Selectively combinable twin working pumps.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

F2W

Worldwide search of patent documents classified in the following areas of the IPC[7]:

E02F, F16H

The following online and other databases have been used in the preparation of this search report:

Online: WPI, EPODOC, PAJ, TXTUS0, TXTUS1, TXTUS2, TXTUS3, TXTEP1, TXTGB1, TXTWO1